N74-10235

Paper No. 3

GENERAL ELECTRIC COMPANY UNDERWATER ENVIRONMENTAL LABORATORY'S ZERO G TECHNIQUES APPLIED TO THE ENVIRONMENT

Ruth H. Fry, *General Electric Company Space Division, Valley Forge, Pennsylvania*

ABSTRACT

The Underwater Environmental Laboratory (UEL) was specifically designed for zero G simulation in an underwater environment to test and evaluate astronaut subjects, manned/unmanned vehicles and equipment.

This paper relates particularly to UEL's recent endeavors in the conversion of zero G simulation techniques applicable to water environmental pollution areas such as oil spill clean-up techniques, thermal pollution, solid waste materials, industrial wastes, storm water discharge and radioactive or nuclear waste evaluation, aircraft emergency ejection studies, automotive water impact and submersion studies, buoy/small submersible development, ocean wave/glitter pattern research and similar areas of water-related research and development.

INTRODUCTION

The UEL is an indoor variably controlled environmental or zero G simulation facility. Its unique capabilities enable it to accommodate virtually any water-related research and development project in the industrial, military, medical, commercial, scientific, or Governmental community. Set forth herein is a description of the manner in which the UEL has revised and up-dated its equipment, zero G techniques and capabilities to serve a larger marketplace in new and non-aerospace activities. Also set forth are a few of these recent programs, such as oil/water separator methods and techniques, remotely-controlled manipulation to be used underwater twenty thousand feet beneath the ocean instead of in space, storm water pollution monitoring systems, vehicle water impact and submersion research and development, buoy and small submersible development and checkouts and radioactive or nuclear waste evaluation. Lastly, described herein are some of the methods in which the UEL evaluated what areas to investigate relative to new business in other industries and fields and how potential customers were approached and apprised of the UEL's existence and unique capabilities.

UNDERWATER ENVIRONMENTAL LABORATORY

The main tank is in-ground 25' deep, 60' long, 28' wide (See Figures 1 and 2), water temperature controlled from approximately 40°F - 120°F - 190°F.

The air temperature in the tank area is controllable from 55°F - 102°F or higher if specifically required. During normal operating conditions the air temperature is maintained at 90°F. The air temperature in other areas of UEL, such as the electronics control room, machine shop, office areas, lounge and medical dispensary, highbay equipment preparation area, conference room, scuba equipment room and locker rooms is maintained at 70°F - 72°F.

The main tank is capable of docking three S-4Bs simultaneously or of performing two or three different experiments simultaneously, dependent upon requirements for each project. The main tank contains 315,000 gallons of water, which is normally completely chlorinated, filtered and purified every 24 hours. However, the UEL presently has the capability of chemically changing 315,000 gallons of fresh water to salt water of almost any density desired for a specific test program.

Built into the main tank is a water manifold pressurization system (a self-contained water supply for water pressurizing Gemini space suits to 3.5 psi). Above this system is an air manifold pressurization system extending 60 feet along one wall of the tank which is used for hookup umbilical helium oxygen deep water (1000-3000') tethered diving experimentation simulated), air pressurization of Apollo suits 3.5 psi, or in performing extended duration submergence physiological testing of selected subjects. To supplement the air pressurization system and to meet NASA, Navy and other customer requirements a two man recompression chamber is available with fully certified Navy trained medical chamber operators. In addition to the above-mentioned air manifold pressurization system and the two-man recompression chamber there is presently tied into the system a compressed air and/or oxygen system (See Figure 3) used for extended submergence studies on hookah and tethered lines and to replenish scuba and other high pressure bottled gas supplies required on programs.

Adjacent to the main 60' long, 28' wide, 25' deep tank is a smaller circular tank 12' in diameter, 8' deep, water temperature controlled from 33°F to 212°F (See Figure 3) This environmental tank may be used for organic R&D such as growing algae, physiological monitoring in cold water experiments and thermal pollution studies.

The UEL is equipped with both surface and underwater TV capabilities whereby monitoring and/or video recording modes may be utilized. The system comprises two underwater cameras, one mobile and one stationary unit, one topside camera, and three surface monitors; each one can be independently connected to the video recorder if desired. Audio surface and underwater communication systems are also available if required for an individual program. Adjacent to the pool area is an electronics control room where from the comfort of a 70°F environment topside personnel monitor the underwater and pool area activities on two closed circuit TV monitors or through a 6' x 8' viewing window opening into the pool area. (See Figure 2).

The lighting system at the UEL consists of windows lining two sides of the pool area in the overhead bay, a spread of thirty-seven 350 watt highbay reflector lamps over the entire overhead bay section, a movable cross bar of 6 to 8, 1000 watts ea.,colortran quartz lights. The cross bar can be raised or lowered to within one foot of water's surface as desired. Also, there is a 25' high photographic catwalk over the tank area. Additional underwater lights, 500 watts each, can be installed at specific locations in the main tank if any underwater supplemental lighting is required. For example, for normal underwater color motion pictures, still photography or TV system utilization, underwater lighting is not a requirement. However, if a test requires spotlighting, backlighting, etc., the underwater lights are excellent for such purposes.

Additional facilities and capability provided are:

- In addition to 315,000 gallon capacity fresh or soft water--murky, dark water can be provided or water visibility from one to sixty feet, capable of reading third to fifth line on standard eye chart.

- This year UEL has the capability of manufacturing 2' simulated waves, fresh or salt water.

- UEL's two ton overhead trolley crane (length of tank area)

- Five ton forklifts (3)

- Highbay area 61' x 25' x 20' high leading from the exterior of the building in the UEL area to the edge of the main tank area for equipment preparation and/or storage for future testing.

Listed below are some typical areas of the marketplace wherein UEL has capability to perform research and development programs and in which areas there is interest, in accomplishing these programs by the customer.

- Simulated "O" gravity for space flight
- Aquanaut equipment development
- Astronaut/aquanaut personnel training
- Environmental pollution studies
- Buoy and small submarine development
- Aircraft emergency ejection studies
- Car submersion rescue techniques
- Nuclear waste containment studies
- Public relations activities
- Underwater TV commercials, special features
- Ocean wave and glitter pattern research

- Coast guard sea rescue equipment development

- Deep sea remote controlled equipment development

All activities and programs at UEL are on a lease basis to General Electric Company components and industrial, military, commercial, scientific, medical and governmental communities alike are subject to a $25 per hour--$200 per day minimum.

UEL NON-AEROSPACE PROGRAMS

Several of UEL's recent activities center in the water environmental pollution area.

Oil/Water Separator

GE's Re-Entry and Environmental Systems Division has developed an oil/water separator to be used on land or offshore. It is a self-contained gravity separation system which requires no operator, has high volume capabilities and is adaptable to existing oil production facilities, both on land and offshore. The separator is designed with non-corrosive materials, has no moving parts, and has been proven in months of field operations to be virtually maintenance-free. The system does not have any external power requirements which place utility demands on the installation site. The only power required is 110V AC to push or pull the bilge mixture to the separator and to pump the separated oil to a suitable storage container.

Presently the oil/water separator is being tested at UEL on a regular basis to develop increased volumetric rates from 1,000 gallons/minute to 5,000 gallons/minute. Because of UEL's capacity of 315,000 gallons, these rates per minute and higher rates are entirely feasible.

Separator efficiency is achieved by design which achieves total laminar flow of the mixture from the input manifold, through baffles and then passes through a combination of specially configured coalescent plates and packs.

With a flow of approximately two feet to maintain capacity flow, the unit operates at atmospheric pressure with essentially no pressure drop from inlet to outlet. While the waste water flows horizontally through the separator, the oil adheres to the plates and moves vertically through the specially configured plate banks. When the oil reaches the liquid surface level in the separator, it is automatically skimmed off by a passive float device that can also control the oil layer thickness to insure that water free oil is removed from the separator.

In addition to utilization in oil production facilities, the separator can also be used for such tasks as ship debilging, refinery and chemical process produced water water clean-up, and assistance in major oil clean-up.

Storm Water Pollution Monitoring System

Another area of water environmental pollution in which UEL has a significant capability is the storm water pollution monitoring system.

Recently a study was conducted by the Environmental Protection Agency to define the water pollution impact of urban storm water discharge. It was discovered that street surface runoff is highly contaminated. In addition, it was found that street cleaning practices and storm drains are ineffective in keeping the fine solids fraction of the street surface contaminants from reaching receiving waters during a storm. The study also showed that the fine solids have the highest pollution potential because they are primarily composed of heavy metals and pesticides which are detrimental to biological systems.

As a result of this study, it was recommended that improved street cleaning practices and newly developed street cleaning equipment could more effectively remove the fine solids from the storm discharge water.

Since the completion of the above study, General Electric has developed a method for monitoring storm water discharge.

In concept, the system is a heavy metals analyzer that is positioned at the desired monitor locations. Prior to a storm the station is automatically operated by remote control using digital codes over a telephone line. The heavy metal data is transmitted by telephone line to a central station where it is recorded and analyzed. Real time heavy metal concentrations in the runoff storm water from many such stations can give a total picture of the storm water in a metropolitan area.

The sensor is an adaptation of a system GE has designed for industrial process line monitoring of the chemical composition of liquids and slurries. The system includes a sensor, recorder, excitation source, power supply and cooling unit.

The sensor operates on the principle of x-ray fluorescence analysis. As the water is circulated through the measurement cell, it is exposed to a source of radiation which causes the elements in the water to emit their characteristic x-rays. The number of x-rays counted by the detector is always proportional to the concentration of each element. In field use each element's x-rays generate discrete voltage pulses in the detector. These pulses are monitored by a programmable single channel analyzer (SCA) and the count rate for each element is transmitted by a data phone line to a central office. Here the data is recorded for future analysis.

A simulated storm drain outfall system will be constructed at UEL for proof testing the water intake designs and pollutant detection sensitivity of the system as a function of water velocity.

Storm water discharges will be simulated by pumping water out of the main test tank of the UEL into the existing storm drain system.(See Figure 4) The main tank of the UEL shown in Figure 1 is 25' x 60' x 28'. The maximum pump-out rate is 315,000 gallons per 24-hour period.

Pollutant detection sensitivity testing under simulated storm conditions will be performed by flushing contaminated street dirt into the UEL existing storm drain system. Contaminated dirt will be collected from streets. The street dirt will be analyzed prior to the storm simulation tests. These tests will then provide sensor detection sensitivity data for various storm water loadings. These data are necessary because the detection sensitivity of the sensor in the storm water monitor is dependent on the total solids contained in the runoff water. The variation in solids will affect the signal to background values. This occurs because the radiation reflected into the sensor by the water plus solids determines the background whereas the characteristic x-rays that are simultaneously generated in the elements contained in the solids determines the detectable signal level.

Additionally, the water intake model will then be constructed to withstand the conditions previously measured in the field. The integrity of the design will be tested at the UEL under conditions equivalent to peak storm conditions.

Lastly, detection sentivity tests will then be performed under simulated storm runoff conditions in the UEL. Detection sensitivities will be established for each of the heavy metals: Ni, Zn, Cu, Cd, Pb and Hg.

Radioactive or Nuclear Waste Evaluation

A further area of UEL capability and participation is in the radioactive or nuclear waste evaluation problem. Namely, the effect of hydrostatic pressure on the performance of a gamma-ray spectrometer; the passive detection of an isotope source; and, determination of the parameters for using activation analyses to identify materials at a distance in water. UEL has the capability of utilization of these three different measurements.

Water Impact and Vehicle Submersion

A quite different endeavor of the UEL in the non-aerospace marketplace is the development of safety standards and procedures in motor vehicle accidents involving water impact and vehicle submersion.

UEL is presently proposing itself to develop practical ways and means of reducing the numbers of accidents involving water impact and vehicle submersion. Presently, very little is known about the behavior and failure characteristics of a motor vehicle upon impact with the water, or during floation, submergence and bottom impact phases. Equally unknown are the psychological difficulties experienced by the victims, or the escape difficulties experienced under varying conditions of vehicle type, post-accident conditions, rest attitude of the vehicle, and water depth.

A review of the small amount of data that is readily available indicates that in those accidents which result in total submersion of the vehicle, the fatality rate is abnormally high. This leads to the speculation that by far the largest percentage of these deaths are caused by drowning. The more important factors contributing to death by drowning under these conditions may be: (1) panic, with the attendant inability to think clearly; (2) inability of the victim to hold his breath long enough to permit escape because of the greatly increased demand for oxygen brought on by fear and panic; (3) ignorance of escape procedures; (4) unconsciousness or other disabling injuries sustained in the accident; (5) jammed windows and doors.

The number of accidents, injuries and deaths involving water impact and submersion may be reduced through: (1) improving highways, along areas bordering water, such as the installation or improvement of guardrails; (2) the development of proven escape procedures under the most prevalent conditions to be encountered, coupled with a thorough education program to make these procedures known to the driving public; (3) determine those design features and modifications which can be incorporated in present and future motor vehicles in order to significantly increase the survival chances of persons involved in accidents of this type. Undoubtedly, the most effective of these changes, if practical and feasible, would be to make motor vehicles virtually unsinkable.

Other Non-Aerospace Programs

During the past year, one of UEL's customers (within General Electric Company) has been developing an unmanned manipulator, initially developed for aerospace utilization, for use in oceanic research at depths of 10,000 to 20,000 feet beneath the sea. Other ocean related programs have been: research and underwater testing of undersea cables, checkout of life support systems and maneuverability of small submissiles and submarines, ocean wave and glitter patterns sensed from orbiting satellites, and research and development in closed cycle mixed gas breathing equipment used by aquanauts to ocean depths of 1,500 to 2,000 feet.

POTENTIAL CUSTOMERS

As may be readily understood from the above typical examples of the variation of non-aerospace problems which may be solved with aerospace technology, the UEL has achieved a degree of interest and capability in other areas of technology, especially in the environmental area.

522-137 O - 73 - 4

As stated previously, the Underwater Environmental Laboratory now has a capability to perform virtually any water-related research and development program and is more than willing to assist other companies, both aerospace and non-aerospace oriented to solve their particular problems in underwater related research and development and to lease the UEL to these organizations to achieve this very worthwhile result.

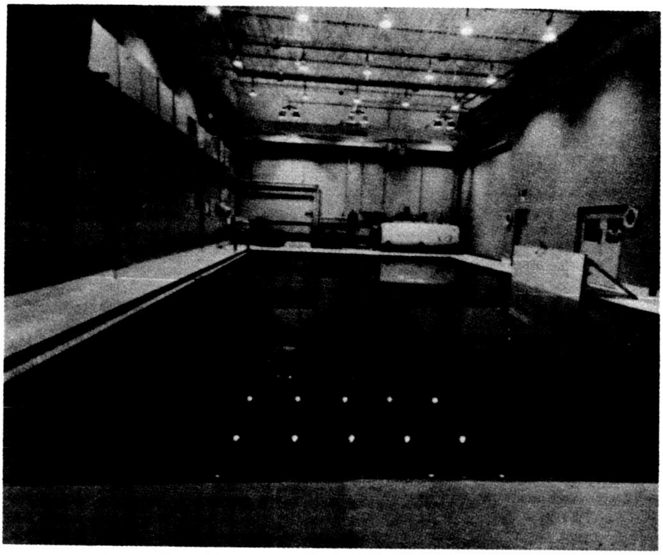

Figure 1

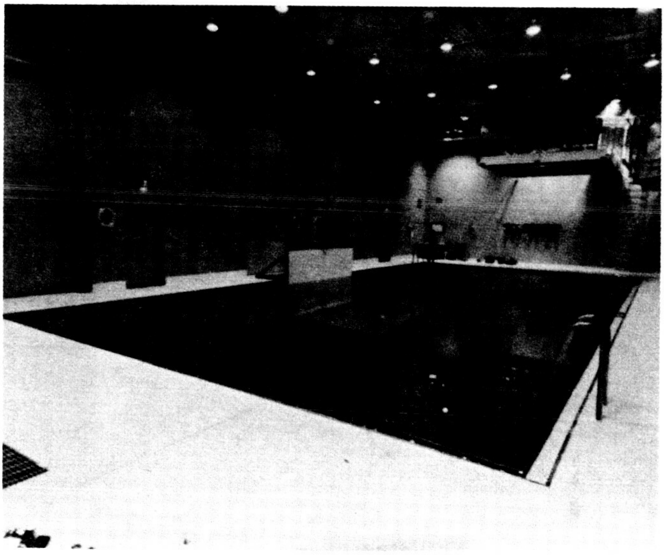

Figure 2

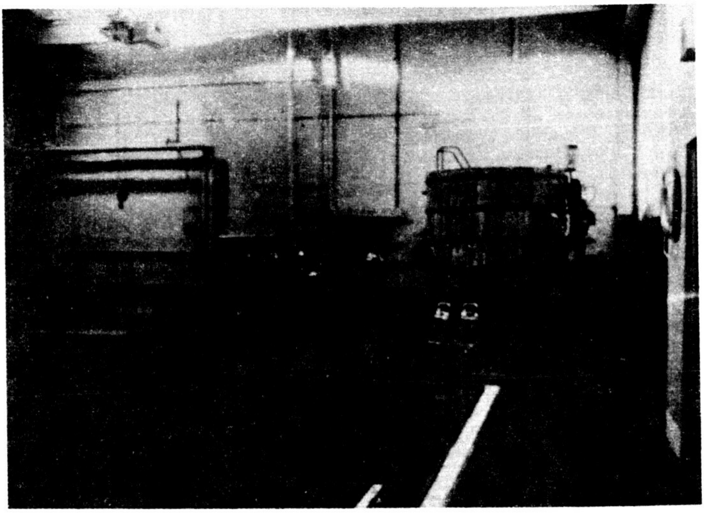

Figure 3

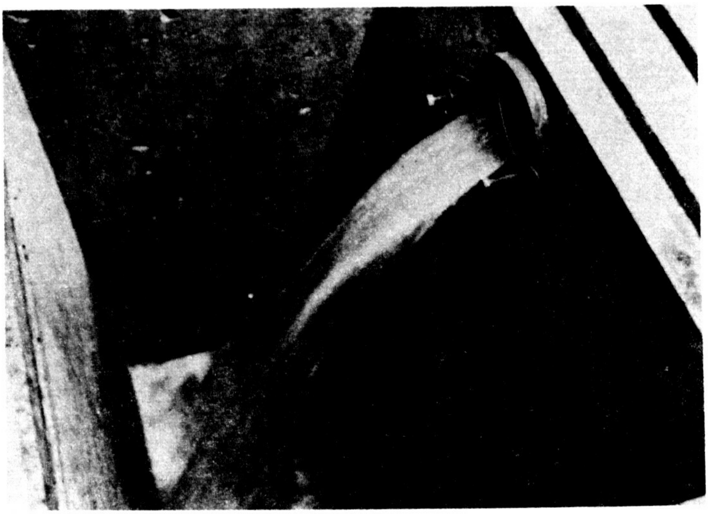

Figure 4